Amendments to the Claims:

This listing of claims will replace all prior versions, and listings of claims in the application:

Listing of Claims:

1. (previously presented) An apparatus for measuring the composition of a mixture flowing through a pipe, said apparatus comprising:

an ultrasonic sensor apparatus disposed along the pipe that transmits an ultrasonic signal through the mixture and receives the ultrasonic signal, to provide a measured signal indicative of the transit time of the ultrasonic signal through the mixture, wherein the mixture includes particles suspended within a fluid; and

a processor, responsive to said measured signal, that determines the speed of sound propagating through the mixture and, responsive to the speed of sound, that determines an output signal indicative of the composition of the mixture flowing through the pipe by determining the speed of sound propagating through the mixture as a function of frequency to characterize dispersion properties of the mixture and comparing the dispersion properties of the mixture to a dispersion model of the mixture.

2. (canceled)

3. (canceled)

4. (previously presented) The apparatus of claim 1, wherein the apparatus is a probe wherein the pipe comprises a tube having an open input end and open output end for receiving the mixture.

5. (previously presented) The apparatus of claim 1, wherein the wavelength of the ultrasonic signal is less than the length scale of the particles within the mixture.

6. (canceled)

7. (canceled)

8. (previously presented) The apparatus of claim 1, wherein the ultrasonic sensor apparatus includes at least three ultrasonic transducers disposed axially along the pipe to determine the transit time.

9. (previously presented) The apparatus of claim 1, wherein the wavelength of the ultrasonic signal is orders of magnitude greater than the length scale of the particles within the mixture.

10. (previously presented) The apparatus of claim 1, wherein the ultrasonic sensor apparatus comprises a first ultrasonic transducer disposed at an axial location along the pipe to transmit the ultrasonic signal into the mixture; and a second ultrasonic transducer disposed at an axial location along the pipe to receive the ultrasonic signal from the ultrasonic transducer.

11. (previously presented) The apparatus of claim 10, wherein the first ultrasonic transducer is axially spaced from the second ultrasonic transducer along the pipe.

12. (previously presented) The apparatus of claim 1, wherein the mixture is liquid droplets suspended in gas.

13. (previously presented) The apparatus of claim 1, wherein the mixture is solid particles suspend in a liquid or gas.

14. (previously presented) The apparatus of claim 1 wherein the dispersion model is empirically derived.

15. (previously presented) The apparatus of claim 1 wherein the dispersion model is numerically derived.

16. (previously presented) An apparatus for measuring the composition of a mixture flowing through a pipe, said apparatus comprising:

an ultrasonic sensor apparatus disposed along the pipe that transmits an ultrasonic signal through the mixture and receives the ultrasonic signal, to provide a measured signal indicative of the transit time of the ultrasonic signal through the mixture, wherein the mixture includes particles suspended within a fluid; and

a processor, responsive to said measured signal, that determines the speed of sound propagating through the mixture and, responsive to the speed of sound, that determines an output signal indicative of the composition of the mixture flowing through the pipe using a dispersion model, wherein the dispersion model is:

$$a_{mix}(\omega) = a_f \sqrt{\frac{1}{1 + \frac{\varphi_p \rho_p}{\rho_f \left(1 + \omega^2 \frac{\rho_p^2 v_p^2}{K^2}\right)}}}$$

wherein a_{mix} is the speed of sound propagating through the mixture, a_f is the speed of sound propagating through the fluid, K is a proportionality constant, ω is frequency in rad/sec, ϕ_p is the volumetric phase fraction of the particles, ρ_p is the density of the particles, υ_p is the volume of individual particles, and ρ_f is the density of the fluid.

17. (previously presented) The apparatus of claim 1 wherein the composition of the mixture includes the phase fraction of the mixture.

18. (previously presented) The apparatus of claim 1 wherein the composition of the mixture includes the size of the particles.

19. (previously presented) An apparatus for measuring the composition of a mixture flowing through a pipe, said apparatus comprising:

an ultrasonic sensor apparatus disposed along the pipe that transmits an ultrasonic signal through the mixture and receives the ultrasonic signal, to provide a measured signal indicative of the transit time of the ultrasonic signal through the mixture, wherein the mixture includes particles suspended within a fluid; and

a processor, responsive to said measured signal, that determines the speed of sound propagating through the mixture and, responsive to the speed of sound, that determines an output signal indicative of the composition of the mixture flowing through the pipe using a dispersion model, wherein the processor compares at least a transitional frequency range of the dispersion model to determine the average size of the particles in the mixture.

20. (previously presented) An apparatus for measuring the composition of a mixture flowing through a pipe, said apparatus comprising:

an ultrasonic sensor apparatus disposed along the pipe that transmits an ultrasonic signal through the mixture and receives the ultrasonic signal, to provide a measured signal indicative of the transit time of the ultrasonic signal through the mixture, wherein the mixture includes particles suspended within a fluid; and

a processor, responsive to said measured signal, that determines the speed of sound propagating through the mixture and, responsive to the speed of sound, that determines an output signal indicative of the composition of the mixture flowing through the pipe using a dispersion model, wherein the processor compares at least one of the lower frequency range and the transitional frequency range of the dispersion model to determine the phase fraction of the mixture.

21. (canceled)

22. (previously presented) A method for measuring the composition of a mixture in a pipe, said method comprising:

measuring the transit time of an ultrasonic signal propagating through the mixture, wherein the mixture includes particles suspended within a fluid; and

determining the composition of the mixture by determining the speed of sound propagating through the mixture as a function of frequency, in response to the measured transit time, to characterize dispersion properties of the mixture and comparing the dispersion properties of the mixture to a dispersion model of the mixture.

23. (canceled)

24. (previously presented) A method for measuring the composition of a mixture in a pipe, said method comprising:

measuring the transit time of an ultrasonic signal propagating through the mixture, wherein the mixture includes particles suspended within a fluid;

determining the composition of the mixture by determining the speed of sound propagating through the mixture in response to the measured transit time, and using a dispersion model, and

comparing at least a transitional frequency range of the dispersion model to determine the average size of the particles in the mixture.

25. (previously presented) A method for measuring the composition of a mixture in a pipe, said method comprising:

measuring the transit time of an ultrasonic signal propagating through the mixture, wherein the mixture includes particles suspended within a fluid;

determining the composition of the mixture by determining the speed of sound propagating through the mixture in response to the measured transit time, and using a dispersion model, and

comparing at least one of the lower frequency range and the transitional frequency range of the dispersion model to determine the phase fraction of the mixture.

26. (canceled)

27. (previously presented) The method of claim 22, wherein the wavelength of the ultrasonic signal is less than the length scale of the particles within the mixture.

28. (previously presented) The method of claim 22, wherein the wavelength of the ultrasonic signal is orders of magnitude greater than the length scale of the particles within the mixture.

29. (previously presented) The method of claim 22, wherein the mixture is liquid droplets suspended in gas.

30. (previously presented) The method of claim 22, wherein the mixture is solid particles suspend in a liquid or gas.

31. (previously presented) The method of claim 22, wherein the dispersion model is empirically derived.

32. (previously presented) The method of claim 22, wherein the dispersion model is numerically derived.

33. (previously presented) The method of claim 22, wherein the composition of the mixture includes the phase fraction of the mixture.

34. (previously presented) The method of claim 22, wherein the composition of the mixture includes the size of the particles.